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Alginate as impression material

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Abstract

There are many materials used to take impressions for patients in dental clinics. The choice of an impression material for a particular situation depends on the treatment being provided and operator preference. Even if a lot of rubber base impression materials with good physical properties was used to take impressions, the alginate material was able to prove its usefulness and has been a staple of most dental practices the world. This article will give a complete explanation of alginate material and the best way to use it when making alginate impressions.

Keywords: Alginate, impressions, irreversible hydrocolloid, impression trays

1. Introduction

The selection of dental materials is based on a reconciliation of their biocompatibility, physical and biomechanical properties, and the acceptability of their esthetic qualities. Ideally, clinical effectiveness of prosthodontics biomaterials should be based on a hierarchy of evidences, including long-term, large-scale clinical trials, as well as strict adherence to internationally recognized specifications and standards that gauge the quality and properties of those materials^[1, 2]. This is important to ensure maximum safety, durability, and effectiveness, which in turn decrease the risk of clinical failures that may result from insufficient knowledge because of a lack of studies of new materials before their full-scale marketing. Over the years, wide varieties of impression materials and their associated techniques have been developed, all striving to achieve the optimum desirable characteristics^[3]. At the present time, hydrocolloids and synthetic elastomeric polymers are among the most commonly used materials to make impressions for the various areas of the dental arch^[4, 5]. Alginate impression material is considered one of the groups often referred to as "elastic impression materials". It was firstly used in 1940s when agar impression material became scarce. Alginate impression material is usually available in the markets in the form of powder, frequently used for preliminary impressions for custom tray fabrication, opposing arch impressions, diagnostics (study models) making extra-oral provisional restorations, and for orthodontic cast records. Alginate is one of the most frequently used dental materials, the versatility of alginate lies in its ease of manipulation, without the need for expensive equipments, its low cost, comfort to patients, relatively technique-insensitive but dimensionally unstable, requiring almost immediate pouring^[6]. They were developed as a substitute for agar when the latter material's supply became scarce during World War II^[7]. Alginate is the material of choice for making preliminary impressions for edentulous patients. However, because of its high viscosity and its ability to displace tissues, it is not recommended for use as a final impression material for complete denture construction^[8]. For many years, alginate impression material has been a staple of most dental practices. They form a major bulk of our clinical practice even today; therefore, it becomes mandatory to understand the material and follow certain fundamental guidelines for flawless, predictable impressions and hence avoid repeat impression/restorations. The purpose of this article is to provide clinical do's and don'ts while using alginate material for impressions.

Composition and Setting Reaction of Alginate

Alginate is provided as a powder, which contains the following ingredients: Potassium or sodium alginate 15%, Calcium sulphate dehydrate 16%, Zinc oxide 4%, Potassium titanium fluoride 3%, Diatomaceous earth 60%, Trisodium phosphate 2%, Coloring agents and

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Flavoring agents^[9, 10]. On mixing the powder with water, a sol is formed, a chemical reaction takes place, and a gel is formed^[11, 12]. Here potassium or sodium alginate dissolves in water and reacts with calcium ions and with calcium sulphate dehydrate to form a dihydrate insoluble alginate gel^[2]. Zinc oxid affects properties and setting time, Potassium titanium fluoride counteracts the inhibiting effect of the hydrocolloid on the setting of stone; ensures good quality surface of the cast, Diatomaceous earth are filler particles, controls the consistency of the mix and the flexibility of the set alginate and Trisodium phosphate controls the setting time to produce either regular or fast-set alginates^[13].

Technical Considerations in the Manipulation of Alginates

The correct powder/liquid ratios, and proper mixing techniques as provided by the manufacturer should be used^[14]. Modifications of these can result in changes in the properties of the gel, tear strength, and elasticity. Alginates are provided in a fast set (1.5 to 3 minutes), and regular set (3 to 4.5 minutes) materials. Altering the water temperature to control setting time may be safely done within a degree or two of a standard temperature $\sim 20^{\circ}$ C. When mixing the material, it must be squeezed between the spatula blade and the side of the rubber bowl, thus minimizing the inclusion of air bubbles and the production of in a porous mix. Powder should be added to the water in the mixing bowl to ensure complete wetting of the powder. The mixing bowl should be clean and without traces of gypsum. Calcium sulphate dehydrate is a common ingredient for both alginate and gypsum and can alter setting time and properties of alginate. Mixing time should be between 45 seconds and 1 minute, depending on the brand^[15]. The setting time can be controlled with the temperature of water used. Alginates can be used with either perforated or nonperforated trays. An adhesive is required if the tray is nonperforated. The tray size is an important factor in the production of accurate impressions. To avoid tears in the impression, a minimum of 3 mm of impression material should be present between the tray and oral tissues. The compressive strength of alginate nearly doubles in the first 4 minutes after gelation, and its elasticity improves over time^[8]. This minimizes distortion during removal of the impression, especially around undercut areas. It is thus recommended to leave the impression in place for at least 3 minutes after gelation before attempting to remove it from the mouth. Alginate is easily poured in gypsum (plaster and stone), and the casts are easily removed from the impressions. Christensen GJ had observed that high points on indirect restorations are a result of inaccurate opposing arch impressions from alginate materials^[16]. Predictable alginate impressions can be made by adhering to a protocol. The steps involved are selection of impression tray, mixing and loading of alginate impression material, preparing the mouth, making the impression, removal/inspection of the impression, and storage and disinfection.

Selection of impression tray

The selection of the correct tray for the dental arch is very important. The impression trays are available in a range of sizes and shapes. These trays are constructed in metal or plastic and may be perforated or unperforated. The stock trays to be selected for alginate should be perforated but alginate adhesives can be used, apart from perforations, for retention of alginate to the impression tray. Use of alginate adhesives overcomes displacing forces during withdrawal of the impression from the mouth. Alginate adhesives are available

as paint-on or spray-on. The use of brush can result in cross-infection of patients. After application of an alginate adhesive, it is allowed to dry for 5 minutes. More frequently, the stock trays would require some customization in the form of tray modification. Modifications can be done with wax, tracing stick impression compound, or heavy-bodied silicone, depending on the operator's convenience. Stick compound is preferable as wax is nonrigid. Impression trays and their modifications should be rigid. Modified impression tray must be placed in the mouth and muscle trimmed. The irreversible hydrocolloids detail are accurately and the most universally used impression materials for primary edentulous impressions. Because they do not absorb the mucous secretions from the palate, they can exhibit defects in the area of the palate. If the patient has a high palatal vault, tracing stick compound can be used in the center of the maxillary tray to reduce the bulk of alginate impression material. In case teeth are missing in one posterior quadrant, modeling compound is softened in a water bath and placed in the tray to make an impression of the edentulous areas. The imprints of the teeth should be cut out with a sharp knife so that the compound has definite stops against the maxillary tuberosity (ensures teeth do not touch the tray and distort impression). Compound is trimmed so that 3 to 5 mm of clearance between compound and mucosa exists except in posterior palatal seal area. This compound modification of the impression tray should be firmly adhering to the tray. If not, wax spatula is heated to merge with the tray borders carefully. The compound surface is softened with a flame, and a ball of cotton is pressed into the surface for a few seconds, leaving short cotton fibers embedded. The cotton fibers provide retention for alginate material. Impression tray is placed in cold water to harden the compound^[17]. The alginate materials must be poured immediately. The weight of the stone, if they are not supported by the borders of the tray, may be sufficient to distort the borders of the impression. Wax or compound may be added to the stock tray border before impression making to extend the borders. Also using a higher viscosity alginate will successfully carry the material into the peripheral areas that are the most difficult to capture, which is commonly the distal buccal of the maxilla and the mylohyoid fossa of the mandible.

Mixing and loading alginate impression material

Commonly used alginate materials are supplied in containers. A scoop is provided for measuring the powder; and a cylindrical plastic measuring cylinder, for measuring the water proportion. Some water supplies contain large amounts of minerals that can affect the accuracy and setting time of the alginate^[18]. In such cases, distilled or demineralized water can be used^[19]. Mixing is initiated by adding measured quantity of water to clean flexible rubber bowl. This is followed by the addition of correctly proportioned powder^[20]. Alginate may be mixed by hand spatulation or mechanical spatulation. Mechanical mixing of alginate ensures that the alginate mix is the same each time they are mixed. The objective is a smooth, bubble-free mix of alginate. In hand spatulation, a measured amount of distilled water at approximately 22° C (72° F) should be placed into a clean rubber mixing bowl. Subsequently, alginate powder should be sifted into the water. Colder water can be used if longer working time is desired. Setting time should be controlled by varying water temperature, and not the consistency of mix^[21]. Mixing should begin slowly using a stiff, broad bladed spatula. When all of the powder has been thoroughly wetted,

the speed of spatulation should be increased. During this process, the spatula should be used to press the alginate impression material against the sides of the bowl. This ensures that the material is completely mixed and minimizes air entrapment. Spatulation should continue for a minimum of 45 seconds. Mixing time is minimum 45 seconds for hand spatulation and 15 seconds for mechanical [2]. The required amount of resultant mix is loaded onto the tray. It should be creamy in consistency but must not drip off the spatula when lifted from the bowl. The tray must be filled with the impression material up to the tray borders and any excess unsupported material (over-filled tray) at the periphery must be removed with the mixing spatula. The surface of the alginate is smoothed with a wet gloved finger [22].

Preparing the mouth of patient before impressions

For dentate cases, occlusal surfaces of teeth should be blown off with an air syringe to remove debris and saliva, in order to minimize air-blows. At the same time, the teeth should not be left to dry completely since alginate material sticks to dried teeth as the thin film overlying the teeth is removed. When the surfaces are dry, the alginate radicals in the impression material form chemical bonds with hydroxyapatite crystals of the enamel; hence alginate tears upon removal [23, 24]. Having the patient rinse with water and mouthwash mixture will eliminate mucin and lower the surface tension, thereby eliminating air bubbles. If repetitive impressions are made with alginate, the film over the teeth is lost and getting a satisfactory impression is prevented. While repeating impressions, the patient must be asked to rinse the mouth to re-hydrate and produce a new film over the teeth for accurate impressions. For removable prostheses, impressions of the sulci are very essential. Hence pre-packing of the sulci, especially lower lingual, upper labial, hamular notch/distobuccal areas, should be considered [25, 26].

Impression making

The mixed alginate should be rubbed onto the occlusal surfaces with a gloved finger to fill the occlusal grooves, allowing accurate reproduction of the occlusal tooth anatomy [27]. Some alginate must be placed in the palatal vault. Impression tray is positioned in the mouth by retracting the patient's lips on one side with a mouth mirror/gloved finger; and on the other side, by rotating the tray into the mouth. The tray has to be centered in position in the mouth; and with light pressure, impression is held in place. The soft tissues, especially labial flange, should be relieved and manipulated for the alginate to flow into the sulci and record the details. When tray is seated, pressure should be released immediately and the tray should be held lightly in place to prevent unseating. It is imperative to release pressure as soon as the tray is seated. Alginate materials start setting from the tooth surface to the impression tray. Pressure will cause impression to set under strain. On removing the impression from mouth, these strains will be released, causing distortion and an inaccurate cast. Moving the impression tray during gelation will incorporate similar strains [18].

Removal, inspection and disinfection of impression

Alginates are strain-rate dependent. The tear strength of alginate increases with the rate at which a stress is applied; thus it is desirable to rapidly remove the impression from the mouth. The impression should not be rocked or twisted before or during removal of the impression. This is to minimize the time for which the set material is distorted as it moves over

the teeth. The seal between tissues and the impression may have to be removed before removal of maxillary impressions, by gently pushing with the gloved finger or by using air-syringe into the buccal sulcus [28]. During removal of the maxillary impression, the operator's index fingers (of both the hands) should be in the buccal sulci to break the seal while thumb holds the tray handle and the other fingers support the impression tray. Upon removal of the impression from the mouth, impression is inspected for defects under good lighting before it is rinsed. Excess unsupported alginate should be removed with a sharp knife. If the tray is left on a firm surface with unsupported material, the impression would distort as the weight of the impression acts directly on the unsupported material. This occurs in the posterior areas of the upper and lower impressions, and it will lead to anteroposterior distortion of the cast. Alginates are dimensionally unstable, they should be poured immediately. The impression can undergo syneresis and imbibition when exposed to air and water if left in a normal clinical environment [29]. However, if the impression cannot be poured for several minutes, the set material should be wrapped in a wet paper towel, which provides a 100% humidity environment [15]. The major component of alginate is water, and if not protected, fluid may evaporate prior to stone being poured into the impression. Even with good intentions, water may be lost from the impression and therefore, in all situations, an alginate impression should be poured within 10 minutes. Once removed from the mouth, the impression should be rinsed with cold water to remove traces of blood or mucin and then be disinfected. Most patients have thin, serous saliva. This type of saliva can be removed by holding the impression under gently running cool tap water. But thick, ropy saliva is difficult to remove. A thin layer of dental stone powder can be sprinkled onto the surface of the impression. The stone adheres to saliva and acts as a disclosing agent [30]. When impression is placed under running tap water, the saliva will be seen and can be removed by light brushing with wet camel's hair brush [20]. The impression is sprayed liberally with the disinfectant, wrapped immediately in a disinfectant-soaked paper towel, and placed in a plastic bag for 10 minutes. The wrapped impression is then removed from the bag, unwrapped, rinsed, and shaken to remove excess water and then is poured immediately [31, 32]. The impression should not be immersed in disinfectant because alginate can easily absorb water and swell, resulting in a distorted impression. Over 60 studies have reported on the effects disinfection has on impression integrity or on the physical characteristics of the casts produced [33-35].

Cast fabrication

Alginate impressions should be poured in gypsum (plaster and stone), using vacuummixed stone and vibrator. A thick mix can trap air bubbles [36]. The stone should be allowed to set in trays with the teeth down. If tray is turned upside down onto base of stone, there would be a tendency for water to rise to the highest point (cusp tips). This can result in faulty, very soft cusps on the model. Inverting the tray may also "bend" alginate away from tray if excess material has not been trimmed away prior to pouring [37]. The casts are easily removed from the impressions. Once poured, stone casts should remain in contact with alginate between 30 to 60 minutes before separation from the impressions to ensure complete setting of the stone. On the other hand, desiccation of the hydrocolloid can occur if the impression is left for a long time, causing abrasion of the cast and poor quality of its

surface.

Conclusion

Making impressions in dentistry is an important part of indirect restorations that is often overlooked. Soon we would be stepping into the era of digital impressions. They can provide unmatched precision, making repeat impressions a thing of the past. Till such time, reliable alginate impressions can be made by following an appropriate technique. Alginates are the most widely used impression materials in dentistry and have many advantages as elastic impression materials including ease of manipulation, low cost, their hydrophilic nature, and ease of pouring. However, when compared with agar and elastomers, they exhibit less elastic recovery, which contributes to increased distortion and reduced reproduction of fine details. Alginates are biocompatible in the oral environment, especially when using dustless alginate powders. The factors that can diminish the accuracy and reliability can be predictably and easily avoided with an understanding of the clinical situation, knowledge of the recent advances, use of skillful technique, and careful observation by both the clinician and the dental technician.

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